Fix the potholes! Helping students translate their interests and life experiences into scientific investigations

by Nicole Beeman-Cadwallader, Cassie Quigley, and Gayle Buck

Many students, particularly those from socioeconomically or resource-challenged communities, often question school science because it has little relevance and bears scant resemblance to the knowledge and skills they use in their everyday lives (Fusco 2001). Differentiated instruction that responds to individual students' and student groups' diverse needs can ensure that science learning becomes both effective and meaningful for them (Tomlinson 1999). One strategy for differentiating science instruction that shows promise is a shift toward valuing students' questions and life experiences (Barton 1998; Upadhyay 2006). Such a shift requires viewing students' home and family experiences as resources, or "funds," of knowledge (Moll 1992). To draw upon these "funds," we need to find out from students themselves what is important to them. Therefore, our challenge as science educators is not identifying students' general interests, but in eliciting rich descriptions of their interests and life experiences, finding overlaps among them, and helping students translate their interests into investigable questions. In this article, we present potential techniques for identifying students' specific interests and important life experiences. Also, we present ideas from our classrooms where we began to help our students practice science that grows out of their interests, concerns, and life experiences.

Strategies for identifying student interests and life experiences

The business card

When describing to students on the first day of school what to expect in our seventh- and eighth-grade science classes, we wished to help them, as well as ourselves, understand and identify students' interests and the sources of knowledge they draw upon to make connections to school science. As one of their first homework assignments, students were provided a 4" × 6" index card and directed to create a business card for themselves in a career they would like to have in the future. On the card, students drew a design to show the title of their career, wrote their name, and created a graphic to represent the career. They also wrote two brief statements on the back of the card; one to describe how they think the career relates to science, and the other to describe where their interest in the career originated. There was great variation in the occupations represented on the business cards, from car mechanic to robotics engineer to cosmetologist to pediatric cardiac surgeon. The purpose of this assignment is to help the teacher and students tap into students' already existing local and familial knowledge to make connections to school science rather than to have students identify a career to pursue, which may be limited by their age and geographic location.

Students' business cards were posted prominently on a large bulletin board in the classroom as a reminder of what was important to them, and we used the cards in planning science units. Career goals such as car

FIGURE 1 Questions to gauge students' interests related to science*

Phase	Purpose	Sample prompts
1	• Identify students' ideas about science outside of school science • Identify students' concerns about their community	• Does anyone do science with you outside of school? What do you learn about? • What are some of the biggest problems where you live? • What are some of your biggest concerns? Do these relate to science?
2	• Elicit students' ideas about science and the work of scientists • Emphasize that scientists have personal reasons for pursuing the science they do	• What is science? • What do scientists study? • Scientists study things that interest them. For example, people who are interested in animals can become veterinarians. People who are interested in space can become astronauts. People who are interested in the human body can become medical doctors.
3	• Identify students' interests, potentially changed or expanded from phase 1 • Help students begin to conceptually connect their interests to science	• Thinking back to the questions we talked about last time (showing students the list), do you have any additional questions or ideas that you are interested in? • How would you make observations to explore these questions? Is it an investigation? How would you collect the data?

* We conducted these phases over the course of the year: one at the beginning of the year, one at the middle, and one toward the end. This is a sample of the questions used in the questionnaires. For a more detailed list, please contact the authors.

mechanic and pyrotechnic designer became entry points into a unit on combustion reactions (see National Science Education Standards, Content Standard B: Physical Science, Transfer of Energy [NRC 1996]). Whenever possible, we directed students' attention to the cards to draw an explicit connection between their interests and the science we were learning in class.

Questionnaires

The business cards were a useful way of identifying students' interests at the beginning of the school year to both use as a resource for instructional planning and to demonstrate to students that including their interests in science learning is important. A different strategy for identifying students' interests in an ongoing fashion is through questionnaires that can be administered through oral interviews with students or in written form. These questionnaires occur in three phases. We conducted them with sixth-grade students, over monthlong periods with at least a week in between, but they could be done over a shorter or longer time span. There were several goals in asking students questions: most importantly, to identify their interests and life experiences, but also to help them relate their interests and life experiences to science and to emphasize to them that scientists have personal reasons for choosing the science they pursue. There were three phases of the questionnaires conducted over the course of the year. In the first phase, questions determined what students identified as science outside of school science, as well as concerns related to their community. In the second phase, we sought students' ideas related to science and the work of scientists. For example, many students were interested in animals, and we talked about how veterinarians were scientists who often love animals and want to help them if they get sick. After students' interests and ideas about science were initially elicited, the third phase sought to identify whether students' interests had changed or expanded over the year and also to help students create a conceptual bridge between their interests and classroom science. Figure 1 lists the purposes and sample questions for each phase. The responses could also be connected to relevant science-content curricula by the teacher or used by students as topics for independent projects. The following two sections outline how to make content connections and help students translate topics into scientific investigations.

Examples of students' interests and their science-content connections

Through the questionnaires, we obtained rich descriptions of what is important to students and began the process of connecting students' interests and life experiences to science and the generation of investigable questions. For example, we saw the following student interests as possible entry points to science investigations: chemicals used in the home (how they help and hurt), weather (tornadoes and floods), potholes (fixing and preventing), and sleep (how the brain functions without it). We connected these entry points to national and state science standards appropriate for middle schoolers, found the overlaps with our local curricula, and translated them into instructional units. In this section, we demonstrate an example of how we elicited students' life experiences related to potholes and helped them draw explicit connections to school science. While the dialogue presented was generated in an oral interview, the same core information could be gained from written questionnaires. If using written questionnaires, a written dialogue between the student(s) and teacher would need to arrive at the same explicit connections between students' interests and life experiences and school science content.

Teacher (T): Are you interested in things in your community?
Student 1 (S1): We could have our roads fixed.
T: Yeah.
Student 2 (S2): We should have creepy houses rebuilt.
S1: Fix the potholes.
T: Maybe learn about why potholes happen and how we can fix those?
S1, S2: Yeah.
S1: People say potholes happen because of the rain.
Student 3: People say the rain and people ride over it too much. That is how my mom got a slit in her tire.
S2: They say it happens because of the salt that they put on the ground that eats it up.
T: Wouldn't that be an interesting thing to study? To try and figure out if you put salt on the ground or if water on the ground causes the potholes? Or snow? Or heat?
S2: Yes.

In this example, students shared their interests related to their community. The dialogue also shows the teacher priming students to connect their interest in potholes to potential science investigations; *students* took that connection a step further and began generating reasons for the existence of potholes. Exploring causes of potholes can be a powerful springboard into science content, allowing students to explore sources and types of weathering and erosion. As appropriately connected to national, state, and local curricula, these questions can be investigated by the whole class or by individual students or student groups in independent or group projects.

Connecting students' interests and life experiences to school science curricula

When sixth-grade students mentioned a few community concerns they had—potholes and "creepy" houses—we followed up with a direct connection to their learning. We asked them, "Maybe learn about why potholes happen and how we can fix those?" This question transformed a general, real-life concern students had, badly damaged roads, into something they could actually pursue in school science. Without further prompting, students followed up with ideas about why the potholes exist. One student said, "People say potholes happen because of the rain." Another made a personal connection to the issue, saying, "That is how my mom got a slit in her tire." Yet another student offered salt that is put on the roads in the winter as a possible cause of damaged roads. The teacher validated and affirmed that the students' ideas would be interesting to study in school science.

These ideas can then be used to connect students' interests and life experiences to science curricula. In this case, tying students' concerns about potholes with the Indiana science standards for grade 6 illuminated connections to science content standards related to weathering and erosion (Indiana's Department of Education, see Grade 6 science, 6.3.12, 6.3.15, and 6.3.18). Short-term field studies near the school could be done to generate recorded observations of potholes. The recorded observations could be taken back to the classroom and used to foster discussions about weathering and erosion. Eventually, class discussions leading to investigable questions could lead into guided-inquiry investigations using materials such as stream tables (see Resources). Appropriate safety measures for all activities and independent student projects are crucial. For example, prior to class investigations exploring causes of potholes, thorough examination of the field site for potential safety hazards can be done by the teacher. The book *Inquiring Safely* is an excellent resource for ensuring safety in school science (Kwan and Texley 2003).

Helping students translate their interests and life experiences into investigable questions

Students do not always jump from a real-world concern to generating questions or explanations that can be investigated without some assistance. To help students identify potential questions to investigate from their concerns and interests, the teacher could ask, "What is a problem you see with ______?" For example, if students mention floods as an interest and community concern, asking the question, "What are some problems you see with floods?" could produce a list of fledgling ideas for scientific investigation. The teacher could prompt further student thinking by asking, "What are some possible ideas about why this problem exists and how to 'fix' it?" Furthermore, the teacher and students could create a "bank" of such questions to draw upon later when selecting topics for independent or group inquiries, end-of-year culminating projects, or science fair projects.

Following is an example of how one seventh-grade student's life experiences were translated into an independent, end-of-year culminating project. The project was an open inquiry project intended to allow students to demonstrate their mastery of the Texas Essential Knowledge and Skills for grade 7 related to inquiry methods (Texas Education Agency, see 7.2 A–E). Throughout the school year, students wrote their interests and life experiences on sticky notes in response to questions like those in phase 3 of the questionnaire sequences, and posted them on one wall in the classroom we called the Wonder Wall. When selecting topics to explore for their independent, culminating open inquiries, students had the option to choose something from the Wonder Wall. Tap water in the Rio Grande Valley in south Texas usually comes from the Rio Grande River, which is generally considered distasteful at best, unsafe at worst. Stands to purchase purified water exist, but it comes at a cost that can strain some financially strapped families. One student posted a sticky note that outlined his dream of building a solar-distillation mechanism that people could use to harness energy from the abundant sunshine in south Texas. Through help from the teacher, he translated this vision and community concern into the following investigatable question: "Can people build a solar distillation mechanism to save money on purified water?" He built several models, tested the quality of the water of each, and eventually presented a model he found to be most effective and manageable for families to build themselves.

Conclusion

The strategies presented in this article provide ways for identifying entry points into students' interests and life experiences that can be connected to school science instruction. Using the business cards in the beginning of the year can help the teacher tap into existing local and familial knowledge that is meaningful to students. The three phases of questions in the questionnaire can be used to discern what students identify as science outside of school and in their community. Also, the teacher can help them build conceptual bridges between community science and school science, and begin the process of helping them translate these into science learning and scientific investigations. While these strategies may not seem particularly new, they have helped us differentiate science instruction in ways that help students see the connections between their lives and what they learn in school science. Through our examples, we also showed how we created classroom science content connections and helped students translate their interests and life experiences into scientific investigations. ■

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Resources

Stream tables—*www.enasco.com/science/Earth+Science/Stream+Tables+&+Soil+Erosion*

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A suggested project-based environmental unit for middle school: Teaching content through inquiry

by Kristin Cook and Ingrid Weiland

Recent science education reform efforts for adolescents have attempted to engage students in science by using project-based instruction (Rivet and Krajcik 2008). The features of project-based learning (PBL) are consistent with the learning needs of many types of students and hold promise as an effective tool for teaching complex topics such as environmental issues. The goal for this project-based waste management unit is to help teachers improve students' understanding of their local environment through a relevant, inquiry-based approach.

Research has shown the benefits of using a PBL approach to include deeper understanding of the subject matter, increased self-direction and motivation, and improved problem-solving abilities (Blumenfeld et al. 1991). Active, social learning is central to inquiry-based recommendations, and cooperative interaction is at the foundation of the PBL strategy. Furthermore, in the PBL approach, teachers act as facilitators to student learning. Students have access to technology in the classroom that allows them to explore and guide their learning, organize their work, and manage their time. This sort of learning environment, coupled with substantial teacher support, has the potential to greatly enhance student participation and engagement with environmental issues.

A project-based approach to teaching waste management

Session 1 (one class session): The unit began with a KWL (know, want to know, and learned) about waste management. Students stated they wanted to know how long certain materials take to break down (e.g., plastic, Styrofoam). Several students had moved to the United States from different countries and shared what their home countries do with their trash. The KWL elicited students' prior knowledge